Hydro-Electric Power Commission

of the

Province of Ontario

SECOND REPORT

TRENT DISTRICT

Printed by Order of the Legislative Assembly of Ontario.
April 17th, 1906.

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GORDON SPROULE .....*Secretary.*

SECOND REPORT

TRENT DISTRICT

To his Honour,

The Lieutenant-Governor of Ontario:—

The undersigned Commissioners appointed by your Honour by Commission bearing date the 26th day of January, 1906, beg leave to submit the following report, as their second report upon the matters authorized and directed to be enquired into.

By the said Commission your Commissioners were authorized to adopt the work of the Commissioners appointed by your Honour by Commission bearing date the 5th day of July, 1905, which was not completed on account of the indisposition and resignation of one of your Commissioners, the consequence of which was that as the powers thereby given were joint, the remaining Commissioners were not authorized to act further in the premises. Your Commissioners accordingly adopted the work of the former Commissioners, and have embodied the results in this report.

Your Commissioners made enquiries and obtained information from various sources, but did not find it necessary to hold formal sittings in this district, as the information which they have obtained has been given freely to members of their engineering staff, who have thoroughly canvassed this district both as to its hydraulic possibilities and its present industrial demands.

Your Commissioners have forborne to give in detail the names of their informants or the particulars of the information acquired from them, but have used the knowledge and facts so acquired for the purposes of computation, comparison, etc., and for the production of the result which they have now the honour to report.

The details, and scientific and technical information obtained have been tabulated and arranged by the Engineer employed by your Commissioners, and are contained in his report which is submitted as an appendix hereto.

The following are the matters on which your Commissioners were authorized and directed to report, with the report upon each subjoined.

DEMAND FOR ELECTRIC POWER.

(1) *"The present and probable demand for hydraulic and electrical power in the various districts capable of being supplied from the different water-powers within the jurisdiction of the Province of Ontario."*

In this second report your Commissioners deal only with that part of Ontario which, roughly speaking, lies north of Lake Ontario, but not including Toronto, and which, for the purposes of this report, may be called the Trent District. This district may be divided into three portions, each of which illustrates a special condition.

(a) The upper Trent valley, due to the construction of the Trent Valley Canal, afforded opportunities for local development, and these have been taken advantage of, so that such municipalities as Peterborough, Lakefield, Lindsay, and Fenelon Falls are well supplied with hydraulic and electric power. Owing, however, to the low heads under which these developments were possible, the total amount of power is not very large, and it appears evident that in the near future it will all be utilized for local consumption, at which time a combination of private interests would tend to raise rates.

(b) In the lower Trent valley far more valuable water-powers exist, and they have only been developed to a very slight extent, and as there are no industrial centres of importance in their immediate vicinity, they are natural sources of transmitted power for supplying the needs of the industrial centres along the north shore of Lake Ontario.

(c) In the Moira river valley a large number of comparatively small water-powers exist, and few are developed, but in time they will be needed to meet local requirements.

Part II. of the Engineer's report on this district affords the necessary details in respect to the preceding remarks.

The demand for electrical power will, in almost all cases, depend upon the relative cost of electricity as compared with that of steam, gas, or other local source of power. The cost of electricity is dependent upon the distance transmitted and the quantity transmitted. As it is only feasible to transmit the power in large quantities, trunk transmission lines capable of carrying large quantities must be constructed, at the outset, therefore the cost increases with the distance,

and a point is eventually reached at such a distance from the generating station that electrical can no longer compete with steam or other local power.

Again, the exhaust steam and heat from the steam plant of some factories is used in the process of manufacture, and it could not be expected that electricity would be adopted by manufacturers of this class for power only, as their production of steam and heat for manufacturing purposes apart from power would increase rather than diminish their expenses; and in many instances waste material is used in the production of steam; such industries have been excluded from the consideration of the extent of the market at present in sight. The capital cost of abandoning steam plants would also, in many cases, be considerable, and the ability of small users of power to bear this loss must always be a factor in the finding of a market.

In order to ascertain the probable market, however, your Commissioners caused enquiries to be made in the various manufacturing centres in the district, with the following results: They are satisfied that an immediate market for at least 10,000 H.P. of electric power can be obtained within a reasonable radius of Healey's, Middle or Rauney's Falls of the Trent river, including the local consumption which would arise, and the power to be supplied to interurban railways. They are also satisfied that this would be increased to at least 15,000 H.P. within five years after electric power was available. This means that power can be distributed as soon as the necessary works are constructed at the medium rates shown in Part V. of the report of the Engineer employed by your Commissioners, and that within five years thereafter the power would doubtless be delivered at a price equal to or even slightly less than the lowest rates shown in the same part of the Engineer's report, which has been computed upon the basis of a return of 4 per cent. interest, a sinking fund and the cost of operating and distributing. Experience shows that where the distribution is controlled by private corporations, the distribution area remains restricted, and from the information obtained by your Commissioners they are able to say that the trend of affairs with private corporations has been not to compete for business, and thus keep down prices to consumers, but to amalgamate or otherwise destroy competition, and then to fix the prices according to the slight saving which they may be able to induce particular customers to make. The natural result of this has been to force individual consumers, where the circumstances justified it, to instal generating

plants of their own, or to adhere to existing methods, rather than to place themselves at the mercy of large combinations formed for the purpose of preventing competition and keeping up the price of electrical power.

Owing to the moderate amount of power required in this district at present and to the fact that there are numerous claimants to, or owners of the three water-powers referred to, but on which there is only one development of 500 H.P., made by the Northumberland Paper Company at Rauney's Falls, and also owing to the fact that the Dominion Government will probably construct their Trent Valley Canal along this route, it would appear advisable that a unified development should take place in this district which would simplify matters and cheapen the cost of power provided such is carried out on the basis of a return upon the cost of operating. If, however, development takes place on behalf of various interests and distribution is carried out by these interests, it can be confidently predicted that not only will the cost of power be greater, but the consumption of electrical power be very much restricted in area and quantity, so that the consumer will not receive any appreciable benefits therefrom.

UNDEVELOPED LOCATIONS.

(2) *"The location, capacity, and capital cost of development of the various water-powers within the legislative jurisdiction of the Province of Ontario at present undeveloped, but whose development is required to supply the present and probable needs of the surrounding districts; and to ascertain the cost of the attendant transmission plant necessary to the utilization of electrical and hydraulic powers to be provided from the aforesaid water-powers within the respective surrounding districts."*

A systematic tabulation of the water-powers of the Trent and Moira rivers based upon gaugings and meterings, supplemented by information derived from other sources, has been carried out during the past six months, and although more minute information, particularly with reference to dry weather flow, could be obtained by continuing the work, it is felt that a fairly accurate hydraulic knowledge of the district has been obtained.

On the upper Trent most of the water-powers have been developed, and of the four undeveloped powers, two have the dams already provided by the Trent Valley Canal, while Burleigh Falls and Buckhorn Rapids must naturally look for their market in Peter-

borough and other neighboring towns. These developments are known to be economical and will doubtless be made as soon as the neighboring market demands it. Your Commissioners did not deem it necessary to make specific studies of these comparatively small water-powers.

The Moira does not possess water-powers of sufficient importance to warrant their being made use of for transmission purposes and their development can safely be left to the united efforts of those parties on the Moira river water-shed who are interested, and who could, by forming a water-power association and incurring a moderate expenditure for storage in Loon Lake and other natural reservoirs, considerably improve the water-powers of the water-shed. Similar action has already been taken by the water-power users on a small river at Gananoque.

Coming, however, to the lower Trent river, your Commissioners find several very important water-powers, which have been previously referred to as the proper source of electrical power to be transmitted to the Lake Ontario industrial centres. In Part V. of the Engineer's report on this district will be found an approximate estimate of the cost of development of five of the more important powers. It should be particularly noted that these estimates do not include vested rights or land damages, which we are unable to estimate, as the Dominion Government, the Provincial Government, the municipality of Campbellford and private owners are all interested.

RATES AND PRICES.

(3). *"To ascertain the rates or prices that would require to be charged the various classes of consumers of hydraulic or electrical power within the respective districts in order to meet all expenditure of maintenance and operation."*

The ascertainment of the rates that would require to be charged for electrical power in order to meet expenditure of maintenance and operation is based upon the cost of necessary plant for future calls upon it, original cost of construction, cost of maintenance and operation, and the probable market for electrical power, ascertained from local enquiries.

In order to ascertain the cost of delivering electrical power in large quantities at particular distances, your Commissioners have made computations with respect to all the municipalities (as localities and not as corporate bodies) which could be conveniently and

economically supplied from Healey's Falls, numbering only nine at the present time (although Campbellford and other towns would be supplied to the extent of their needs as soon as electrical power was available) and the rates or prices for such delivery are shown in Part V. of the Engineer's report.

Your Commissioners call attention to the fact, however, that when electricity is delivered at a municipal sub-station as above, the cost of distribution among the consumers within such municipality must be added to this price in order to determine the cost to the individual municipal consumer.

In order to determine the cost to municipalities using power your Commissioners have ascertained the prices at which electricity could be delivered to consumers at two typical points, namely, Kingston and Oshawa. These rates are set out in Part IV. of the Engineer's report. Also in Part V. of the Engineer's report, Table XII., will be found estimates of the cost of supplying individual large consumers at from two to [illegible] miles from a municipal sub-station computed according to distance transmitted and quantity used.

SAVINGS.

(4) *"To enquire into and ascertain the annual savings accruing to the consumers in the various districts aforesaid by the substitution of the rates or prices in the next preceding paragraph for the rates paid at present in the said districts so far as the Commissioners may be able to ascertain or estimate them."*

The estimated saving in the purchase of power that would result from the charging of prices or rates based on actual cost as ascertained and shown in the next preceding part of this report has been worked out for Oshawa and Kingston, as typical of the other municipalities affected, and are shown in Part XII. of the Engineer's report on this district.

The annual amount of savings which might accrue is very difficult to estimate because each town has its peculiarities. If some industries could be encouraged sufficiently by cheap power they might operate 24 hours per day; others might be willing to give limited hour contracts for the winter season; and the town pumping if done by the municipality and where reservoir capacity is available might also be done chiefly by night. All these factors have such an intimate

bearing on the solution that any estimate can only be considered approximate. However, the estimates given in Part XII. of the Engineer's report are considered to be conservative.

CAPITAL COST OF UNDERTAKINGS.

(5) *" To enquire into and ascertain the cash capital cost of the hydraulic and electrical power undertakings of existing companies located within the Province of Ontario; the capacity and state of development thereof."*

Your Commissioners have not yet taken steps to ascertain the cash capital cost of the present developments on the upper Trent river; to do so would not appear to serve any useful purpose at the present time, owing to the fact that in most cases the dams and reservoirs have been provided by the Dominion Government, and therefore the cost would not be fairly comparable with hydraulic developments made in ordinary unimproved locations. The present developments are known to be very economical, and enable power to be sold at fairly reasonable rates.

POWER SUPPLIED AND UNDER CONTRACT BY THE EXISTING COMPANIES.

(a) *" The quantities supplied and contracted for and the rates charged and to be charged under such contracts by these companies for hydraulic and electrical power."*

In Part II. of the Engineer's report, Tables I., II., and III. will be found the amounts of hydraulic and electrical power at present developed, and which are seen to be quite extensive in the upper Trent Valley, while in the lower Trent Valley considerable hydraulic development exists at Campbellford and Frankford.

The prices or rates charged for power and light in various municipalities in the Trent District are set forth in Part IX. It will be noted that the charges for street- and house-lighting are not appreciably less in the upper Trent valley, where water-power developments have already been made than in the Lake Ontario towns, where light is supplied by steam plants, and that all of the hydraulic developments referred to are made by private companies. There is practically no electrical power for sale in the Lake Ontario district, while a large amount is sold in the upper Trent district at moderate rates.

APPRAISEMENT OF UNDERTAKINGS.

"(b) *The actual present value of the said undertakings, or such portion thereof as may be required, after making such fair and reasonable allowances for existing conditions as in the judgment of the Commissioners seems necessary or expedient.*"

As previously mentioned in Clause 5 above, your Commissioners did not consider it necessary at the present time to make an estimate of the value of the hydro-electric plants at present in operation in the upper Trent district, as, owing to the dams and headworks being supplied by the Dominion Government, no useful comparison can be made between the estimates of these plants and the cost of ordinary complete undertakings.

(c) "*To estimate the capital outlay, if any, necessary to complete these undertakings.*"

Your Commissioners are not aware of any undertakings, which at the present time are being constructed, or increased materially in capacity, although doubtless additional machinery is being installed in various plants from time to time sufficient to meet increased demands.

Your Commissioners respectfully submit that the conditions in this district are not only peculiar, but important.

In the upper Trent district numerous water-powers exist, and these have been developed, and doubtless will be still further developed as local demands require, until all of the water-power available will be fully in use, but, owing to the location of these water-powers, they do not require concerted action on a large scale, and can be safely left to local enterprise, safeguarded as to rates by such regulations with respect to the selling price as your Honour-in-Council may deem advisable to enact.

In the lower Trent district, however, and along the north shore of Lake Ontario, the condition exists that there is an industrial demand which can be supplied from undeveloped water-powers of considerable capacity located considerable distances from the industrial centres referred to. Concerted action appears to be vital to the success of the undertaking aiming at the development of these water-powers and the supplying of the electrical energy generated to the industrial centres requiring it. The water-powers are held, as already mentioned, by varied interests, but should several development and distribution systems, each of smaller size, be undertaken, the total

cost will be increased, and the larger unified transmission scheme outlined by your Commissioners will be rendered more expensive and possibly prevent it ever being carried into effect.

By combining several of these water-powers in one undertaking, connecting them in parallel to one transmission system, and operating under one administration, only such expenditure need be made as the demand from year to year warranted; and only such power-houses and machinery in each power-house be operated from hour to hour as the total demand required. The economy and certainty resultant from such a method of operation is evident. It is also evident that any hydraulic development along the route of the Trent Valley Canal would have to be constructed in a manner satisfactory to the Dominion Government, and located in such a position as would be consistent with the construction and operation of the canal. On the other hand, the construction of this canal will still further improve the already excellent storage capacity and uniformity of flow of the Trent river, and if the power developments are carried out along with canal construction, considerable economy in first cost will result.

All of which is respectfully submitted.

(Sgd.) Adam Beck,
Chairman.
(Sgd.) George Pattinson,
(Sgd.) John Milne.

Toronto, April 17th, 1906.

APPENDIX

TO

SECOND REPORT

TRENT DISTRICT

ENGINEER'S REPORT

ON

THE GENERATION, TRANSMISSION AND DISTRIBUTION OF ELECTRIC POWER

Honourable Adam Beck,

Chairman of the Hydro-Electric Power Commission:

Dear Sir,—

Herewith find my report on the Trent District. The report deals with the present demand for power within economical transmission distance of the Trent River water-powers and the cost of generating, transmitting, and distributing electric energy within this area.

Yours respectfully,

CECIL B. SMITH,
Chief Engineer.

Toronto, Canada,
Arril 17th, 1906.

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TO

TABLES AND MAPS.

PART I.

GEOGRAPHICAL SUBDIVISIONS.

The Trent and Moira Rivers afford a source of hydro-electric power which can be made available over a district extending from Pickering on the west to Kingston on the east, and from Lake Ontario as far northward as industrial centres now exist, representing, roughly speaking, the water-sheds of these two rivers.

Investigation shows that the water-powers of the upper Trent, although numerous, do not total much more than is at the present time being made use of, and it is evident that all of the water-powers available in the upper Trent waters will be required locally in the near future.

Along the lower Trent, southward from Hastings, and along the Moira river, the industrial development is not so great, and the water-powers, and particularly those of the Trent, are more important, and offer an opportunity to develop a large amount of power for transmission to the present industrial market existing in the towns along the north shore of Lake Ontario.

The water-powers of the Moira river and its tributaries are numerous and a considerable number of them can be economically developed, but none of them are of sufficient importance to justify their being developed for the purpose of long-distance transmission of electricity. They will doubtless be all utilized in time for local purposes—in mining, generating electricity for local use, also for direct hydraulic use in paper and flour mills.

On the other hand, the towns along the north shore of Lake Ontario must for all time depend for their hydro-electric power on the water-powers above referred to, as, outside of these two rivers the small streams flowing into Lake Ontario are not of sufficient importance to consider as sources of any considerable amounts of power.

PART II.

DEMANDS FOR HYDRAULIC AND ELECTRIC POWER.

As a basis for estimates a careful canvass was made by expert assistants in each town and city of this district. In this canvass, care was taken to determine whether or not the consumer would be likely to adopt electric power if it were available at reasonable rates, the canvass including also present use of hydraulic and electric power. In the tables following these various classes of consumers are tabulated so that an estimate can be arrived at of the available market for future electric power, and in tables I., II., and III. this information is set forth in detail.

The map accompanying this report indicates the location of the chief water-powers of the Upper Trent river, and a specific scheme has been worked out, by which certain of the present available markets might be supplied from central of these water-powers. It will be noted that several smaller towns have not been taken into consideration; in some cases because the consumption would not warrant the necessary expenditure, and in other cases because the towns are already supplied locally. The latter remarks apply particularly to Trenton, Tweed, Marmora, etc.

TABLE I.

POWER CONDITIONS.

UPPER TRENT VALLEY.

MUNICIPALITY.	Total Power Used.	Hydraulic Power Used Direct. H.P.	Electric Power Developed. H.P.	Steam Power Available for Electric Installation. H.P.
Peterborough	5,500	260	5,000	330
Lakefield	2,880	460	1,860	....
Lindsay	1,165	250	....	450
Fenelon Falls	1,250	....	1,250	....
Millbrook	70	70	50	50
Cannington	195	50	125	125
Port Perry	270	.	.	95
Total	11,800	1,090	8,285	1,050

TABLE II.

POWER CONDITIONS.
MOIRA AND LOWER TRENT.

MUNICIPALITY.	Total Power Used. H.P.	Hydraulic Power Used Direct. H.P.	Electric Power Developed. H.P.	Steam Power Available for Electric Installation. H.P.
Campbellford	1,200	1,100	80	25
Marmora	380	280	100	....
Frankford	950	850	....	....
Tweed	350	125	100	50
Madoc	180	....	....	125
Stirling	80	70	....	....
Marlbank	1,000	....	....	1,000
Total	4,140	2,425	280	1,200

TABLE III.

POWER CONDITIONS.

LAKE ONTARIO MUNICIPALITIES.

MUNICIPALITY.	Total Power Used. H.P.	Hydraulic Power Used Direct. H.P.	Electric Power Developed. H.P.	Steam Power Available for Electric Installation. H.P.
Kingston	2,600	....	....	2,200
Deseronto	3,200	....	....	750
Belleville	2,065	375	250	*3,600
Cobourg	780	30	160	730
Port Hope	1,125	525	100	500
Bowmanville	670	125	100	400
Oshawa	1,640	....	100	1,460
Whitby	380	....	90	250
Colborne	130	30	40	60
Brighton	90	20	50	.....
Trenton	1,375	800	250	....
Pickering	60	....	....	68
Napanee	425	425	....	100
Total	14,540	2,330	1,140	10,118

* Including the proposed cement plant.

PART III.

SOURCES OF HYDRO-ELECTRIC POWER.

Aside from some smaller streams which flow into Lake Ontario, which have not been taken into consideration, the sources of hydro-electric power for this district are, as before-mentioned, the Trent and Moira rivers.

The water-powers of the Trent river may be divided into those of the upper Trent valley lying west of Hastings, and those of the lower Trent valley to the south of this point, and those of the Moira

river and its tributaries. The last-mentioned are shown in Table IV.; it will be seen that, although numerous, no one of them is large enough to be considered as a source of electric power to be transmitted to any distance, and local use will in time be found for all the power available on this river.

On the upper Trent there are a large number of moderate-sized water-powers, as shown in Table V., but comparing Table V. with Table I., it will be noted that large developments have already taken place, and all that remains will be needed in the near future within the immediate district itself.

TABLE IV.

SHOWING WATER-POWERS ON THE MOIRA RIVER AND TRIBUTARIES.

Location of Water-Power.	Total Head Ft.	Estimated Power at Low Water. H.P.	Power Now Developed. H.P.
Belleville			
1st dam		00	110
2nd dam	6		0
Undeveloped	15	550	....
3rd dam	9.4	340	65
4th dam	8.6	320	50
5th dam	8	300	50
Chisholm's Mills	10	370	..
Lost Channel		33	
Tweed:—			
Old electric light plant	10	230	...
Deseronto Milling Company	10	230	100
Electric Light Co.	9	200	100
Undeveloped power	6	140	....
Glen Lewis	8	6	....
Actinolite	30	350	Partially developed
High Falls	35	410	Undeveloped.
Long Slides	5	550	Undeveloped.
Total		4,900	585

TABLE V.

WATER-POWERS ON UPPER TRENT RIVER.

Location of Water-Power.	Total Head. Ft.	Estimated Power at Low Water. H.P.	Power Now Developed. H.P.
Peterborough :—			
Peterborough Hydraulic Power Company	....	3,200	3,200
Auburn Mills	12	1,100	680
Water Works	10	900	70
Canada General Electric	15	1,365	1,400
No. 5 dam, Otonabee Power Co.	14	1,280	1,700
No. 4 dam	12	1,100	Undeveloped.
No. 3 dam	12	1,100	1,350
No. 2 dam	10	900	Undeveloped.
No. 1 dam	12	1,100	640
Young's Point	7	600	535
Burleigh Falls	25	1,800	Undeveloped.
Buckhorn Rapids	12	870	Undeveloped.
Bobcaygeon	6	300	300
Fenelon Falls	24	720	1,600
Elliott's Falls	21.5	930	930
Total		17,265	12,405

TABLE VI.

WATER-POWERS ON LOWER TRENT RIVER.

Location of Water-Power.	Total Head. Ft.	Estimated Power at Low Water. H.P.	Power Now Developed. H.P.
Trenton	14	2,500	900
Rapids ¾ mile above Trenton	18	3,200	Undeveloped.
Glen Miller	9.5	1,750	600
Rapids 1½ miles above Glen Miller	18	3,200	Undeveloped.
Frankford	12	2,150	Undeveloped.
Trent Valley Paper Co.	14.6	2,580	800
Chisholm's Rapids	12	2,100	Undeveloped.
Rauney's Falls	35	6,100	500
Campbellford	9	1,550	500
Rapids	15	2,580	100
Middle Falls	30	5,200	150
Rapids	12	1,600	Undeveloped.
Healey's Falls	60	8,000	Undeveloped.
Hastings	7.5	1,000	475
Total		43,510	4,025

PART IV.

GENERATION OF POWER.

On the lower Trent river, however, the water-powers are much more extensive and are practically undeveloped, the only ones used so far being small developments for paper mills, etc.

Of the various water-powers shown in Table VI. at least five are worthy of being fully developed for long-distance transmission, namely: Healey's Falls, Middle Falls, Rauney's Falls, Rapids one and one-half miles above Glen Miller, and Rapids three-quarters of a mile above Trenton. Table VI. shows that the total dry-weather capacity of these five developments would be 25,600 H.P., more than sufficient to supply, for the present at least, all industrial demands of the Lake Ontario towns.

At the present time it would not be necessary to develop all these water-powers, but as the demands for electric power increase these water-powers could be developed one by one, all being worked in unison and under one management. This district would appear to be one in which united management with one set of transmission lines to the various towns would be far more economical than would be the case if several Companies were to take up the various water-powers and develop and transmit the power independently.

Table VII. gives an approximate estimate of the cost of the five water-power developments as previously enumerated, but these estimates must be considered quite approximate, owing to the likelihood of the Trent Valley Canal modifying designs which would be otherwise proper for a power plant; and also because the field engineering work for these estimates has necessarily been very meagre. However, it is probable that these estimates are correct within 10 per cent.

TABLE VII.

SHOWING CAPITAL COST OF POWER DEVELOPMENTS LOWER TRENT RIVER.

Location of Water-Power.	Amount of Power Developed. H.P.	Total Capital Cost.	Cost per H.P.
Healey's Falls	8,000	$ 675,000	$ 84 [illegible]
Middle Falls	5,200	475,000	91 [illegible]
Rauney's Falls	6,000	425,000	69 [illegible]
Rapids above Glen Miller	3,200	350,000	109 [illegible]
Rapids above Trenton	3,200	370,000	115 [illegible]
Totals	25,600	$2,295,000	

Note.—Capital cost to cover hydraulic development (such as dams, weirs, pipe-lines), power-house, hydraulic and electrical equipment, with one spare unit, and step-up transformer station with electrical equipment, but do not include cost of vested rights and land damages.

TABLE VII.A.

ESTIMATE OF YEARLY OPERATING EXPENSES OF GENERATING PLANTS.

Items.	Middle Falls. 5,200 H.P.	Healey's Falls. 8,000 H.P.	Combined. 13,200 H.P.
Operating expenses, including administration	$11,875	$16,875	$23,000
Maintenance and repairs	9,500	13,500	23,000
Replacement fund	9,500	13,500	23,000
Interest at 4 per cent.	19,000	27,000	46,000
Total yearly charges	$49,875	$70,875	$115,000

It will be noted that the operating expenses on the combined plants are estimated as less than on the two individual plants due to the reduced administration costs.

In order to determine the cost per H.P. per year allowance must

TABLE VIII.

TRENT DISTRICT.

TRANSMISSION DETAIL SHEET,

SHOWING CAPITAL COSTS AND ANNUAL CHARGES.

SECTION	Length, Miles.	Size of Wire, M.C.M.	Capital Cost per Mile. Equipment	Right of Way and Fencing	Engineering Contingencies and Interest during Construction.	Total.	Total Capital Cost.	Capital Charges per Mile. Interest and Renewals. Equipment	Right of Way and Fencing.	Engineering and Contingencies.	Total.	Total Capital Charges.	Patrol per Mile.	Total Patrol.	Total Annual Charges	Full Load Loss of Power, K.W.	2,122 K.W., Kingston. Full Load Loss of Power, K.W.	Annual Charges.	970 K.W., Marlbank. Full Load Loss of Power, K.W.	Annual Charges.	730 K.W., Deseronto. Full Load Loss of Power, K.W.	Annual Charges.	3,460 K.W., Belleville. Full Load Loss of Power, K.W.	Annual Charges.	244 K.W., Whitby. Full Load Loss of Power, K.W.	Annual Charges.	1,410 K.W., Oshawa. Full Load Loss of Power, K.W.	Annual Charges.	392 K.W., Bowmanville. Full Load Loss of Power, K.W.	Annual Charges.	490 K.W., Port Hope. Full Load Loss of Power, K.W.	Annual Charges.	713 K.W., Cobourg. Full Load Loss of Power, K.W.	Annual Charges
Kingston to Deseronto Jct	34	77.8	$1,630	$350	$396	$2,376	$80,684	$125.30	$24.25	$29.91	$179.46	$6,101.64	$50	$1,700	$7,801.64	67.	67	$7,802																
Marlbank to Deseronto Jct	15½	41.6	1,404	500	381	2,285	35,417	110.70	36.25	29.39	176.34	2,733.27	30	465	3,198.27	10.			10	$3,198														
Deseronto to Deseronto Jct	8½	41.6	1,404	500	381	2,285	19,422	110.70	36.25	29.39	176.34	1,498.89	30	255	1,753.89	3.					3	$1,754												
Deseronto Jct. to Belleville	14	107.5	2,588	350	588	3,526	49,364	164.77	24.25	37.80	226.82	3,175.48	50	700	3,875.48	51.	29	2,174	12	973	10	728												
Belleville to Brighton	25	205.0	3,518	350	774	4,642	116,050	211.49	24.25	47.15	282.89	7,072.25	50	1,250	8,322.25	174.	52	2,489	23	1,113	17	834	82	$3,886										
Whitby to Oshawa	5	41.6	1,404	350	351	2,105	10,525	110.70	24.25	26.99	161.94	809.70	40	200	1,009.70	0.2									0.2	$1,010								
Oshawa to Bowmanville	10	45.3	1,510	350	372	2,232	22,320	119.30	24.25	28.71	172.26	1,722.60	50	500	2,222.60	15.									2.	328	13	$1,895						
Bowmanville to Port Hope	20	55.8	1,610	350	392	2,352	47,040	124.30	24.25	29.71	178.26	3,565.20	50	1,000	4,565.20	38.									[illegible]	546	26	[illegible]	7	[illegible]				
Port Hope to Cobourg	7	68.0	1,740.	350	418	2,508	17,556	130.80	24.25	31.01	186.06	1,302.42	50	350	1,652.42	17.									2.	160	9	924	2	255	4	$313		
Cobourg to Brighton	23	88.5	1,924	350	455	2,729	62,767	140.00	24.25	32.85	197.10	4,533.30	50	1,150	5,683.30	69.									5.	433	31	2,496	8	685	10	846	15	$1,223
Brighton to Healy Falls	25	[illegible]	4,981	600	1,116	[illegible]	167,425	[illegible]	43.00	68.51	411.05	10,276.25	60	1,500	11,776.25	243.	50	2,436	22	1,086	17	[illegible]	79	3,806	6.	275	[illegible]	[illegible]	[illegible]	[illegible]	11	[illegible]	10	782
TOTAL							628,570								51,861.00	687.	198	14,901	67	6,370	47	4,131	161	7,692	20.	2,752	112	10,067	26	2,243	25	1,699	31	2,005

TABLE IX.

TRENT DISTRICT.

TRANSFORMATION DETAIL SHEET,

SHOWING CAPITAL COSTS AND ANNUAL CHARGES.

MUNICIPALITY.	Capacity of Installation. Full and Partial Load.	K.W.	CAPITAL COST.			ANNUAL CHARGES.							
						Depreciation.			Insurance.				
			Building.	Electrical Equipment.	Total.	Building, 1%.	Equipment, 7%.	Taxes, 2%.	Buildings, 30c. per $100 per Year.	Equipment, 40c. per $100 per Year.	Interest, 4%.	Operation.	Total Annual Cost.
Kingston	Full	2 662	$43 000	$43,000	$46,000	$30 00	$3,010 00	$60 00	$9 00	$172 00	$1 840 00	$720	$5,881
	¾	1 516	33,000	32,250	35,250	30 00	2,257 50	60 00	9 00	129 00	1 410 00	720	4,616
	½	1 034	24,000	24,500	26,500	30 00	1,505 00	60 00	9 00	86 00	1060 00	720	3,370
	Full	938	2,180	25,070	27,250	21 80	1,755 00	43 60	6 54	100 00	1,090 00	700	3,717
Marlbank	¾	700	2 180	18,788	20,968	21 80	1,351 00	43 60	6 54	75 00	839 00	700	2,957
	½	469	2,180	12,535	14,715	21.80	878.00	43.60	6.54	50.00	588.00	700	2,288
	Full	702	1,700	17,100	18,800	17 00	1,197 00	34 00	5 10	68 40	752 00	300	2,374
Pecaonto	¾	525	1,700	12,800	14,500	17 00	896 00	34 00	5.10	51 20	580 00	300	1,883
	½	351	1,700	8,550	10,250	17 00	598 50	34 00	5 10	34 20	410 00	300	1,399
	Full	3 875	4,500	57,500	62,000	45 00	4,025 00	90 00	13 50	230 00	2,480 00	720	7,604
Belleville	¾	2,550	4,500	43,000	47,500	45 00	3,010 00	90 00	13 50	172 00	1,900 00	720	5,951
	½	1,687	4,500	28,750	33,250	45.00	2,012.50	90.00	13.50	115.00	1,330.00	720	4,326
	Full	284	1,090	1,250	10,340	10 90	647 50	21 80	3 27	37 60	414 00	300	1,434
Whitby	¾	175	1 090	6,937	8,028	10 90	485 50	21 80	3 27	27 75	321 08	300	1 170
	½	117	1,090	4,625	5,715	10.90	323.75	21.80	3.27	18.50	228.60	300	907
	Full	1 460	2,500	28,500	31,000	25 00	1,995 00	50 00	7 50	114 00	1,240 00	700	4,132
Oshawa	¾	1 020	2,500	21,500	24,000	25 00	1,505 00	50 00	7 50	86 00	960 00	700	3,334
	½	685	2,500	14,250	16,750	25 00	998 50	50 00	7 50	57 00	670 00	700	2,508
	Full	474	1,090	10,850	11,930	10 90	762 50	21 80	3 27	43 60	479 00	300	1,622
Bowmanville	¾	280	1,090	8,175	9,265	10 90	572 25	21 80	3 27	32 70	370 60	300	1,311
	½	187	1,090	5,450	6,540	10 90	381 50	21 80	3 27	21 80	261 60	300	1,001
	Full	168	1,360	12,900	13,260	13 60	871 00	27 20	4 08	55 60	610 45	300	1,984
Port Hope	¾	350	1,360	10,400	11,760	13 60	728 00	27 20	4 08	41 60	470 40	300	1,585
	½	234	1,360	6,950	8,310	13.60	486.50	27.20	4.08	27.80	332.40	300	1,192
	Full	683	1 700	17 100	18,800	17 00	1,197 00	34 00	5 10	68 40	752 00	300	2,374
Cobourg	¾	510	1,700	12,800	14,500	17 00	896 00	34 00	5 10	51 20	580 00	300	1,883
	½	341	1,700	8,550	10,250	17.00	598.50	34.00	5.10	34.20	410.00	300	1,399

TABLE X.

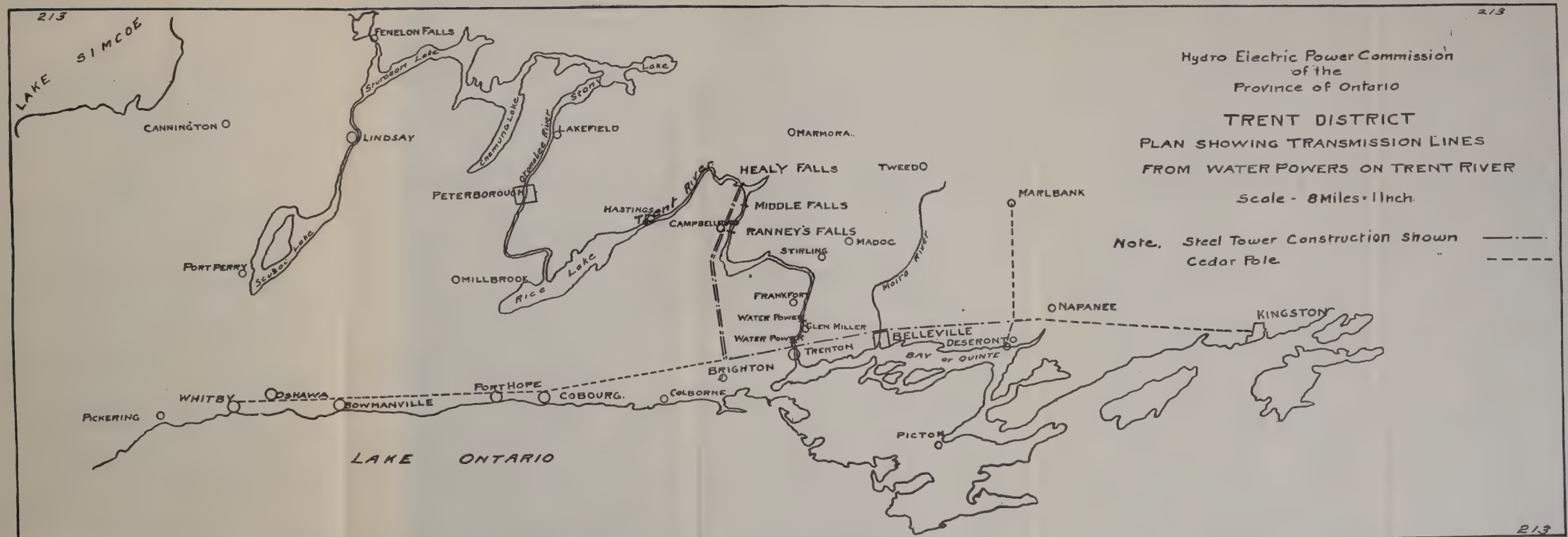
TRENT DISTRICT.

SUMMATION SHEET.

SHOWING TOTAL AMOUNT OF POWER REQUIRED AND ANNUAL COST OF SAME ON 24 HOUR BASIS AT SUB-STATION LOW TENSION BUS BARS.

MUNICIPALITY.	Population.	Present Power Used. Total.	Portion Admitting Electrical Installation.	Estimated Future Load. Full and Partial.		Regulation at Full Load. Per Cent.	*Cost of 24-Hour Power at High Tension per Horse Power Delivered.	Annual Charges. Transmission. Total.	Transmission. Per Horse Power.	Transformation. Total.	Transformation. Per Horse Power.	Interswitching. Total.	Interswitching. Per Horse Power.	Administration. Total.	Administration. Per Horse Power.	Total Cost of 24-Hour Power at Low Tension Bus Bars, Sub-down Transformer Stations.
Kingston	19,400	2,600	2,200	Full	2,750	1.3	$13.50	$14,902	$5.42	$5,841	$2.12	$ 81	.03	$977	.36	$21.43
				¾	12,062		12.98	14,902	7.22	4,587	2.22	81	.04	895	.43	22.89
				½	1,375		12.90	14,902	10.84	3,390	2.46	81	.06	812	.59	26.35
Marlbank	250	1,000	1,000	Full	1,250	0.3	13.26	6,370	5.10	3,717	2.98	210	.18	444	.36	21.88
				¾	938		12.94	6,370	6.80	3,037	3.23	210	.19	407	.43	23.59
				½	625		12.86	6,370	10.20	2,288	3.66	210	.21	370	.59	27.52
Deseronto	3,300	3,200	750	Full	936	0.0	13.30	4,131	4.42	2,374	2.54	164	.18	332	.36	20.82
				¾	702		12.98	4,131	5.89	1,883	2.68	164	.19	305	.43	22.17
				½	468		12.89	4,131	8.84	1,399	2.99	164	.21	278	.59	24.72
Belleville	10,200	2,065	3,600	Full	4,500	1.0	12.87	7,692	1.71	7,604	1.69	131	.03	1,598	.36	16.66
				¾	3,375		12.64	7,692	2.28	5,951	1.77	131	.04	1,464	.43	17.16
				½	2,250		12.57	7,692	3.42	4,326	1.92	131	.06	1,329	.59	18.56
Whitby	2,250	380	250	Full	312	0.3	13.52	2,752	8.82	1,434	4.60	9	.03	111	.36	27.33
				¾	234		13.10	2,752	11.75	1,170	5.00	9	.04	101	.43	30.32
				½	156		13.04	2,752	17.64	907	5.82	9	.06	91	.59	37.15
Oshawa	4,920	1,640	1,460	Full	1,825	0.3	13.35	10,067	5.51	4,132	2.27	54	.03	549	.36	21.52
				¾	1,368		12.93	10,067	7.34	3,334	2.42	54	.04	593	.43	23.16
				½	912		12.87	10,067	11.02	2,508	2.75	54	.06	536	.59	27.29
Bowmanville	4,000	670	400	Full	500	0.2	13.40	2,243	4.49	1,622	3.24	15	.03	178	.36	21.52
				¾	375		12.90	2,243	5.99	1,312	3.50	15	.04	162	.43	22.86
				½	250		12.85	2,243	8.98	1,001	4.00	15	.06	146	.59	26.48
Port Hope	4,400	1,125	500	Full	625	1.0	13.20	1,699	2.72	1,984	3.18	19	.03	222	.36	19.49
				¾	468		12.93	1,699	3.63	1,585	3.38	19	.04	203	.43	20.41
				½	312		12.86	1,699	5.44	1,192	3.82	19	.06	184	.59	22.77
Cobourg	5,000	780	730	Full	910	1.3	13.10	2,005	2.20	2,374	2.61	27	.03	324	.36	18.30
				¾	682		12.90	2,005	2.93	1,883	2.76	27	.04	295	.43	19.06
				½	455		12.82	2,005	4.40	1,399	3.08	27	.06	266	.59	20.95

* Includes Power Losses to Delivery Points and is based on a price of $12 per 24-Hour Horse Power at the High Tension Bus Bars of Transformer Station at Healy's Falls, on the Trent River.



Hydro Electric Power Commission
of the
Province of Ontario

TRENT DISTRICT

PLAN SHOWING TRANSMISSION LINES FROM WATER POWERS ON TRENT RIVER

Scale - 8 Miles = 1 Inch.

Note. Steel Tower Construction Shown —·—·—
Cedar Pole ----------

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be made for transformer losses in the step-up station, which, with units of such size as would be installed, might be taken at 4 per cent. The net amount of power and costs per H.P. would be as follows:

TABLE VII.B.

Net amount of power	4,990 H.P.	7,680 H.P.	12,670 H.P.
Yearly cost of 24-hour power transformed ready for transmission	$10.00	$9.10	$9.08

PART V.

TRANSMISSION OF POWER.

Taking as a present source of power Healey's Falls, with an auxiliary development at Middle or Rauney's Falls, or both, a development and transmission scheme has been worked out, supplying power to all of the Lake towns from Whitby to Kingston, inclusive.

A private right of way is provided for in the estimates, 66 feet wide from Healey's Falls to Brighton, and of a varying width along the Grand Trunk Railway from this point to Whitby on the west and to Kingston on the east. The following line construction is provided for: double-circuit steel towers from the power-house to Brighton; single-circuit steel towers from Brighton to Deseronto Junction (the name given to the point where the Deseronto and Marlbank lines branch off) and high-class wood pole construction from Deseronto Junction to Kingston, and from Brighton to Whitby.

The transmission detail sheet will be found to contain in tabular form the detailed capital cost of, and annual charges on, the transmission lines from the step-up transformer station to the step-down sub-stations. It also shows the distribution of these charges and the loss of power between the various municipalities, according to a given estimated distribution of demand among them. These charges could be readily adjusted to other proportionate demands on the part of the municipalities participating. The capital charges include depreciation, and taxes on the right of way, and the item called "Engineering and Contingencies" includes interest during construction. It is assumed that the transmission lines would be erected at the outset with a full future load capacity, and therefore the total charges would remain fixed.

The transmission detail sheet shows that buildings would be erected

for full future load conditions, but with equipment installed as required; therefore, the total fixed charge for transformation varies with the load. The full future load capacity has been placed 25 per cent. in advance of the estimated present demand and the relative three-quarter and half-loads are taken on this future demand, and are therefore respectively 93 3-4 per cent. and 62 1-2 per cent. of the estimated present available market. The transformation charges provide for municipal taxes on site and building, insurance, depreciation, and 20 per cent. for engineering, contingencies and interest during construction.

In the summation sheet will be found the charges for transmission and transformation chargeable to each municipality, with the necessary charges for an inter-switching station at Brighton, and for administration; and the summation shows the cost of 24-hour power at the low-tension bus-bars of the sub-stations located in the outskirts of the municipalities. The column showing cost of power at Healey's Falls includes line and sub-station transformer losses and is based on a cost of $12.00 per 24-hour H.P. per annum at the high-tension bus-bars of the generating station.

The cost of power is largely influenced by the amount transmitted, the explanation of which will be found in the fact that the charges on transmission are fixed for a given line irrespective of the amount of power transmitted. The resultant cost to each municipality will also be found to be dependent upon all the other municipalities providing their relative estimated market.

In the following table is shown in condensed form the total investment, annual charges, and cost of low-tension power at the municipal sub-stations (sub-stations included).

TABLE XI.

	Full Load.	¾ Load.	½ Load.
Total H.P distributed	13,608	10,206	6,804
Total investment, including step-down stations and inter-switching	$878,885	$823,216	$767,725
Investment per H.P. delivered	64.58	80.66	111.36
Total annual repairs, depreciation, patrolling and operation and administration	53,343	48,838	44,284
Annual interest, 4 per cent. on investment	35,155	32,929	30,709
Total annual charges	$88,498	$81,767	$74,993
Cost of 24-hour power, including line and step-down sub-station transformer losses:—			
Kingston	21.43	22.89	26.85
Marlbank	21.88	23.39	27.52
Deseronto	20.82	22.17	25.52
Belleville	16.66	17.16	18.56
Whitby	27.33	30.32	37.15
Oshawa	21.52	23.16	27.29
Bowmanville	21.52	22.86	26.48
Port Hope	19.49	20.41	22.77
Cobourg	18.30	19.06	20.95

The general scheme on which the estimates are based involves three-phase, 25-cycle generation, and transformation to and transmission at 55,000 to 60,000 volts. The step-down transformer station estimates have been made on the basis of 2,200 volts as a municipal distributing voltage, and the entire capital and operating charges of these stations are included in the prices of power as given in the summation sheet.

Applications may arise from municipalities or individuals for power at points distant from the transmission line, and the additional charges for an individual branch line from any municipal sub-station and sufficient transformer capacity is given in the following table.

TABLE XII.

Showing cost of distribution from municipal sub-station to an individual consumer, not covered by local distribution.

Distance in miles from Municipal sub-station.	Cost per horse-power per annum for the delivery of various amounts of power							
	50 H.P.	75 H.P.	100 H.P.	50 H.P.	200 H.P.	250 H.P.	300 H.P.	
2	$ 5.58	$ 4.20	$ 3.53	$ 2.92	$2.74	$2.60	$2.51	2,200 Volts.
3	6.89	5.20	4.41	3.60	3.25	3.10	3.03	
4	7.92	6.18	5.20	4.27	3.93	3.72	3.86	
5	8.87	7.18	5.98	4.96	4.55	4.32	4.17	
6	10.20	8.24	6.77	5.38	5.13	4.60	4.45	
8	14.10	10.14	8.40	6.97	6.24	5.79	5.58	11,000 Volts.
10	16.12	12.13	9.54	8.31	7.68	6.96	6.17	
12	18.76	14.03	11.12	10.12	8.42	7.96	7.22	16,500 Volts.
15	22.74	17.08	13.48	10.89	9.35	8.84	8.32	

The total cost of power to such a consumer is ascertained by adding the rate per H.P. from this table to the cost of power at the nearest municipal sub-station. The charges for a branch transmission do not include any allowance for right of way or telephone, it being assumed that the highways would be available for such low voltage lines.

PART VI.

DISTRIBUTION OF POWER.

The next step required to be taken is the determination of the additional cost of the distribution of power from a given municipal sub-station to the consumers' premises, and of the installation of service transformers where these are necessary. To arrive at this cost accurately necessitates the complete design of a distributing system for the given municipality, but it has been considered sufficient to take two places, namely, Oshawa and Kingston, and consider them as typical of the remaining municipalities.

OSHAWA.—Distribution to the present probable consumers in Oshawa, with an allowance of 25 per cent. additional for future growth, and with service transformers where necessary, requires a capital investment of $48,900, with total annual charges, including operation, repairs, replacement fund and interest at 4 1-2 per cent. of $8,910. This amount also includes the cost of the power lost in distribution and transformation.

The following table, on the basis of the proportionate loads shown in the summation sheet, gives the cost of 24-hour power distributed to the consumers' premises in Oshawa:

TABLE XIII.

Amount of Power Delivered.	Cost of 24-hour Power per [illegible]		
	At Healey's Falls, including line and step-down sub-station losses.	At Sub-station.	At Customers'.
Full Load, 1,825 H.P.	$13.35	$21.[illegible]	$26.30
¾ Load, 1,368 H.P.	12.93	23.16	29.67
½ Load, 912 H.P.	12.87	27.[illegible]	37.06

The final costs as given in this table do not take into account the overlapping of customers' maximum demands, and these prices would be considerably modified for any system of charges on maximum demand, but would practically hold for a combined charge of a meter rate added to a rate based on maximum demand. Seventeen industries were considered as likely to use electric power, at distances from the municipal receiving station ranging up to one and one-half miles.

KINGSTON.—In this city twelve industries were considered as admitting of electrical installation at varying distances from the sub-station, up to two and one-half miles. The necessary capital expenditure for a distribution system would be $93,200 with total annual charges of $12,976, including line and transformer losses at maximum demand. Adding the cost per H.P. to that already obtained in the summation sheet, the following costs would result:

TABLE XIV.

Amount of Power Delivered.	Cost of 24-hour Power per H.P. per Annum.		
	At Healey's Falls, including line and step-down sub-station losses.	At Sub-station.	At Customers'
Full Load, 2,750 H.P.	$13.50	$21.43	$26.15
¾ Load, 2,062 H.P.	12.98	22.89	29.19
½ Load, 1,375 H.P.	12.90	26.85	36.29

The same remarks will apply to the final costs arrived at in this case as in the case of Oshawa. In Kingston, however, the conditions seem more favorable to a considerable modification of final costs, due to better prospects of obtaining limited hour motor contracts.

As the larger proportion of power sold is required for 10 hours only it is evident that this power will be available for lighting and pumping purposes after six o'clock p.m., to a municipality free of cost to them, but during the winter season there is a period between 4.30 p.m. and 6 p.m. not provided for, and in order to have free power for lighting purposes available all the year through, it becomes necessary to make what are called "limited hour contracts," by which certain motor users will agree to shut down during this period, namely 4.30 p.m. to 6 p.m., for say five months of the year. The compensation which it becomes necessary to make to these motor users under such an arrangement represents, evidently, the cost to the municipality of an equivalent of power for peak lighting purposes.

The utilization of the idle electric transmission capacity during the night for municipal pumping purposes will, of course, be seen to be dependent on the possession of sufficient storage capacity in reservoir or standpipe to carry the municipality over the daytime.

PART VII.

MOTOR INSTALLATIONS.

To complete the information regarding the cost of electric power to the consumer, the following table is given, showing the cost of induction motor service per H.P. per year.

TABLE XV.

CAPITAL COST AND ANNUAL CHARGES ON MOTOR INSTALLATIONS. POLYPHASE 25-CYCLE, INDUCTION MOTORS.

Capacity. H.P.	Capital Cost per H.P. Installed.	Annual Charges.			
		Interest, 5%.	Depreciation and Repairs, 6%.	Oil, Care and Operation.	Total per H.P per Annum.
5	$41.00	$2.05	$2.46	$4.00	$8.51
10	39.00	1.95	2.34	3.00	7.29
15	35.00	1.75	2.10	2.50	6.35
25	28.00	1.40	1.88	2.00	5.28
35	25.00	1.25	1.50	1.75	4.50
50	24.00	1.20	1.44	1.50	4.14
75	21.00	1.05	1.26	1.25	3.56
100	20.00	1.00	1.20	1.00	3.20
150	17.00	.85	1.02	.80	2.67
200	16.00	.80	.96	.70	2.46

By combining the results given in this table with the previously worked out cost of power as obtained for Oshawa and Kingston (or for any other town or city, making an allowance for distribution from the municipal sub-station to the customer of from $3.00 to $7.00 per H.P. per year), a total charge per H.P. per year will be obtained, which represents to any customer the entire yearly charge for electric power, including (as shown in tables) interest, repairs, replacement fund and operating charges.

PART VIII.

SINKING FUND.

In the above estimates for transmission and transformation, depreciation and replacement charges have been provided for which would replace the different classes of plant in periods ranging from 15 to 40 years. These depreciation charges would, therefore, amply serve the purpose of any sinking fund which might be considered needful. In the case of the generating plant estimates, however, the depreciation charges would not be sufficient for such a purpose in the so-called permanent portions of the development, comprising the dam, headworks and power-house. If a forty-year sinking fund were considered needful, a charge would have to be made on some $45 expenditure per

H.P. of capacity sufficient to repay this expenditure in 40 years; a charge of $0.62 per H.P. per annum at 3 per cent. would meet this demand.

PART IX.

EXISTING RATES.

In Table XVI. will be found a fairly complete statement of the rates now being charged for electric light and power throughout this district. It will be noticed that the upper portion of the table pertains to the towns in the upper Trent valley, now generally supplied by hydro-electric power, while the lower portion gives the rates in the municipalities on or adjacent to Lake Ontario.

TABLE XVI.

Showing comparison of rates for power and light in various municipalities in the Trent District.

Municipality.	Street Arc Lighting, per Year.	Incandescent Lighting.				Power. Flat Rate per H.P. per Year.
		Commercial.		Residential.		
		Meter Rate per K.W. Hr.	Flat Rate per Year.	Meter Rate per K.W. Hr.	Flat Rate per Year.	
Peterborough Light & Power Co.	$50.00 (moonlight)	10c.	....	7½c.	....	$20 to $40
Otonabee Power Co., Peterborough	....	.....	$3.00	....	$1.50	$20 to $35
Lakefield.....	$60.00	.....	$5.00	....	$3.00	$20
Lindsay.....	50.00 (all night, every night)	12½c.	....	12½c.	....	$20 to $35
Whitby..... (municipal)	$36.00 (moonlight, midnight)	10c.	....	10c.	....	.....
Oshawa.....	$65.00 (moonlight, all night)	8½c. to 15c.	....	8½c. to 15c.	....	.....
Bowmanville.....	$46.50 (midnight)	10c.	....	10c.	....	.....
Port Hope.....	$54 00 (moonlight)	.....	$5 00	. .	$3.00	
Cobourg.....	$62.50	18.2c.	....	18.2c.	....	.....
Trenton.....	.....	9c.	....	8c.	....	$20
Belleville.....	$58.00	10c.	....	8c.	....	$30 Meter rate. 8c. per K.W. Hr.
Kingston..... (municipal)	60.00 (moonlight)	12½c.	....	12½c.	....	

PART X.

STEAM POWER.

In order to institute a comparison between the cost of electric power as has just been set forth and the cost of power generated by steam or producer gas, the following tables have been compiled after a careful study of data available in technical journals and also from data collected by the Commission's engineers in various towns within the district under consideration. The capital costs have been compiled from information supplied by various makers of engines and other machinery. The tables represent average working conditions and assume a high class installation.

TABLE XVII.

STEAM POWER PLANTS.

Showing capital costs of plants installed and annual costs of power per brake horse-power.

Size of Plant, H.P.	Capital Cost of Plant per H.P. Installed.			Annual Cost of 10-hour Power per B.H.P	Annual Cost of 24-hour Power per B.H.P.
	Engines, Boilers, etc., Installed.	Buildings.	Total.		
	CLASS I.—Engines: Simple, slide-valve, non-condensing. Boilers: Return tubular.				
10	$66.00	$40.00	$106.00	$91.16	$180.76
20	56.00	37.00	93.00	76.31	151.48
30	48.70	35.00	83.70	66.46	131.68
40	44.75	33.50	78.25	59.49	117.74
50	43.00	31.00	74.00	53.95	106.46
	CLASS II.—Engines: Simple, Corliss, non-condensing. Boilers: Return tubular.				
30	$70.70	$35.00	$105.70	$61.14	$117.70
40	62.85	33.50	96.35	55.50	107.10
50	59.00	31.00	90.00	50.70	97.73
60	56.00	30.00	86.70	47.42	91.34
80	50.00	27.50	77.50	43.86	85.41
100	44.60	25.00	69.60	40.55	79.19
	CLASS III.—Engines: Compound, Corliss, condensing. Boilers: Return tubular with reserve capacity.				
100	$63.40	$28.00	$91.40	$33.18	$60.05
150	53.70	24.00	77.70	29.83	54.63
200	50.10	20.00	70.10	28.14	51.72
300	45.90	18.00	63.90	26.27	48.83
400	43.55	16.00	59.55	24.84	46.12
500	41.25	14.00	55.25	23.73	44.21
750	40.50	13.00	53.50	23.56	44.02
1,000	39.00	12.00	51.00	23.26	43.71
	CLASS IV.—Engines: Compound, Corliss, condensing. Boilers: Water-tube with reserve capacity.				
300	$55.20	$18.00	$73.20	$25.77	$46.32
400	51.50	16.00	67.50	24.18	43.61
500	49.40	14.00	63.40	23.19	42.03
750	46.80	13.00	59.70	22.88	41.56
1,000	44.30	12.00	56.80	22.47	41.11

NOTE: Annual costs include interest at 5 per cent., depreciation and repairs on plant, oil and waste, labor and fuel, (coal at $4.00 per ton). Brake horse-power is the mechanical power at engine shaft.

It will be noted that for a consumer requiring a large installation, operating for ten hours only, there appears to be little advantage to be derived from the use of transmitted electric power, provided the power is not to be distributed throughout a consumer's buildings by a complicated system of shafting, belts, etc. But in the majority of cases this condition obtains, and herein lies one of the specific advantages of electric power. Motors can be installed on each floor of a factory, or even on each machine, with but little loss in efficiency, and only such motors as are required to drive the machinery in use from time to time need to be operated. In many cases due to this fact the total electric power consumption of a large factory would be reduced from 25 per cent. to 50 per cent. below that which is required under steam operation, working from a central station.

Again where electric power is available throughout the 24 hours many industries will work night and day thereby effecting a great economy, as is evidenced by a comparison of the cost of 24-hour steam or producer gas power with 24-hour electric power.

Perhaps the most striking advantage to be derived from the use of electric power as compared with other power is that the small consumer can obtain power at a rate which should not be appreciably greater than that made to the large consumer, although the present practice in selling electric power is to discriminate against the small consumer for the reason that electric power prices made by private companies are not based on cost of service, but are merely made with a view to displacing steam.

PART XI

PRODUCER GAS POWER.

TABLE XVIII.

SHOWING CAPITAL COSTS OF PRODUCER GAS PLANTS INSTALLED AND ANNUAL COSTS OF POWER PER BRAKE HORSE-POWER.

Size of Plant, H.P.	Capital Cost of Plant per H.P. Installed.			Annual Cost of 10-hour Power per B.H.P.	Annual Cost of 24-hour Power per B.H.P.
	Machinery, etc.	Buildings.	Total.		
10	$137.00	$40.00	$177.00	$53.48	$90.02
20	110.00	36.00	146.00	44.47	75.22
30	93.00	33.00	126.00	38.73	65.99
40	84.50	29.00	113.50	35.05	59.85
50	80.00	26.00	106.00	32.27	55.22
60	79.00	24.00	103.00	30.49	52.03
80	78.20	22.00	100.20	28.70	48.95
100	77.50	20.00	97.50	27.05	45.40
150	76.00	19.00	95.00	25.87	43.17
200	74.00	17.00	91.00	24.95	41.78
300	73.00	16.00	89.00	24.24	40.40
400	71.50	14.00	85.50	23.41	39.03
500	70.00	12.00	82.00	22.54	37.54
750	67.50	10.00	77.50	21.55	35.99
1,000	65.00	8.00	73.00	20.46	34.66

NOTE: Annual costs include: interest at 5 per cent., depreciation and repairs on plant, oil and waste, labor and fuel (Bituminous coal at $4.00 and Anthracite coal at $5.00 per ton).

A reference to Table XVII. will show that the cost of power developed by producer-gas plants and gas engines is less than that produced by steam plants of the same capacity. It may be said, however, that up to the present no very large installations of suction producers have been made, 250 to 300 horse-power being about the maximum. But this has been provided for in the table by assuming that the larger plants will be made up of several units, each unit being not greater than 350 H.P. capacity. While operation of producer-gas plants has not been going on many years, and complete knowledge on the subject is not available, with the information at hand it is believed that in many situations this form of power producer will be found more economical than a steam plant, and therefore a closer competitor of hydro-electric power. It must be remembered that the same objections hold against the producer-gas plant as those which have been

mentioned in reference to steam plants, namely, that 24-hour power costs proportionately more than 10-hour power; that the small consumer does not have the great advantage obtainable by the use of electric power; and also that a central installation in a factory is all that is possible if electric motors are required in various parts of the factory, and the only prime mover available is steam or gas. This will make the cost of electric factory operation very expensive, and considerably higher than the power costs shown in Table XVII. Speaking generally, however, it may be said that producer-gas plants have a bright future, and as the design and construction is perfected undoubtedly the capital cost will be reduced and the cost of power lessened.

TABLE XIX.

Showing the effect on the cost of power of a variation in the price of coal of one-half dollar per ton.

Size of Plant, H.P.	Suction Producer Gas.		Steam.		
	10-Hour.	24-Hour.	10-Hour.		24-Hour.
10	$1.15	$2.53	Simple slide valve engine.	$6.14	$13.47
20	1.13	2.46		5.25	11.56
30	1.10	2.40		4.71	10.35
40	1.07	2.33	Simple automatic non-condensing.	3.56	7.84
50	1.04	2.29		3.37	7.41
60	1.01	2.24		3.26	7.16
80	.98	2.18		3.15	6.97
100	.96	2.12		3.12	6.87
150	.94	2.07	Compound condensing.	1.75	3.85
200	.92	2.02		1.69	3.71
300	.90	1.98		1.62	3.60
400	.88	1.94		1.56	3.44
500	.86	1.89	Compound condensing water-tube boilers.	1.39	3.05
750	.82	1.81		1.39	3.05
1,000	.76	1.72		1.39	3.05

PART XII.

SAVINGS.

In Oshawa, at the present time, the probable amount of steam power which could be economically replaced by electric installations is 1,500 H.P., costing annually, in operating expenses alone, apart from heating, etc., about $52,500. The amount of electric power necessary to replace this would be the 3-4 load of table XIII. or

1,368 H.P., costing $40,589, showing a yearly saving, to power users alone, of $11,919, besides cheap power for lighting and pumping.

In Kingston it is estimated that 2,062 H.P., costing $60,190, could replace about 2,400 H.P., costing in operation expenses alone $89,200, a saving, to power users alone, of $29,100 per year, besides cheap power for lighting and pumping.

It may be confidently predicted that the above estimated savings would even be exceeded in actual practice, because of two considerations; first, the difference between the actual total electric power to be used and the steam power displaced by it would be even greater than shown due to overlapping, limited hour contracts, etc.; and second, taking the cost of electric power as for 10-hour power, (the displaced steam power being for the same period) the remaining idle capacity, over and above that used for pumping and lighting, could be utilized throughout the remainder of the day, through any possible channels at a merely nominal cost.